FINAL REPORT: FNAS Training Grant/Stark-Kublin - JANUARY 1995

NGT-50701, Acct 5-30158

A STUDY OF ALFVEN WAVE REFLECTION IN RELATION TO SOLAR CORONAL HOLES

The proposed studies to investigate the physics of Alfvén wave reflection in solar coronal holes included numerical simulation of Alfvén wave propagation in a stratified medium and application of the results to interpretation of Alfvén wave propagation in inhomogeneous solar coronal holes. The main goals of these studies were: (1) To investigate how efficiently Alfvén waves are reflected in solar coronal holes and how the reflected waves might contribute to local coronal heating through nonlinear generation of longitudinal waves. (2) To calculate the wave pressure accelerating force exerted by Alfvén waves on the atmosphere and estimate its contribution to the solar wind acceleration. (3) To evaluate the range of periods and amplitudes of those Alfvén waves which are leaking into the solar wind. This work is part of ongoing research between the University of Alabama in Huntsville (UAH) and NASA's Marshall Space Flight Center (MSFC) was supervised by UAH faculty advisor, Dr. Zdzislaw E. Musielak, and Dr. Steven T. Suess at MSFC.

The numerical code for these studies required extensive coding and careful attention was given to proper specification of boundary conditions due to sensitivity of the second order effects (energy flux, wave force) being investigated. As a result of the simulations run, it was found that resonance effects play a significant role in nearly every aspect of the physics in this model. By calculating the amplitudes of the time averaged transverse and longitudinal wave flux, and observing these variables versus height in the domain, a measure of the reflection and amount of coupling can be made within the context of resonance effects. The initiation of the induced longitudinal flow due to the Alfvén wave pressure force acting on the medium was determined in both the linear and nonlinear regimes for periods ranging from 25s (very short - WKB) to 1500s (non-WKB with significant reflection). Due to the role of resonances in this model, it was difficult to estimate the amplitudes and periods of the leakage of waves into the solar wind from this simulated section of a coronal hole.

During the period of performance of this grant, Ms. Stark-Kublin completed coursework and the preliminary and qualifying exams required for the Ph.D. program. All results are presently being compiled into final form with the dissertation defense scheduled for mid-February. Ms. Stark-Kublin has been awarded

a National Research Council Associateship at the Space Science Lab of NASA/MSFC to begin in mid-March and will continue to work in the field of solar physics. In addition to the following list of presentations and papers that have already resulted from this work, we expect three additional papers to result from the present results; one outlining the numerical code to be submitted to the *Journal of Computational Physics* and two papers discussing the solar physics applications of the simulation results to be submitted to the *Astrophysical Journal.*

FINAL REPORT: Fnas Training Grant/Stark-Kublin - JANUARY 1995

NGT-50701, Acct 5-30158

PAPERS AND PRESENTATIONS RESULTING FROM THIS WORK:

- *The Cutoff Frequency for Fast-Mode Magnetohydrodynamic Waves in an Isothermal Atmosphere with a Uniform Horizontal Magnetic Field* – refereed paper,
  Astrophysical Journal, 409, p. 450; May, 1993

- *Critical Frequencies and Reflection of Alfvén and Fast Mode Waves in an Isothermal Atmosphere* – poster,
  21st Solar Physics Division (SPD) Meeting of the American Astronomical Society (AAS),
  Huntsville, AL – May 1991

- *Critical Frequencies and Reflection of Fast Mode Waves in the Solar Atmosphere* – talk,
  179th AAS General Meeting,
  Atlanta, GA – January 1992

- *Critical Frequencies and Reflection of MHD Waves* – talk,
  Solar Physics Division Seminar: MSFC,
  Huntsville, AL – February 1992

- *Plasma Code Modification for Plane Parallel Constant Magnetic Field Configuration* – talk,
  Institut für Theoretische Astrophysik, University of Heidelberg,
  Heidelberg, Germany – July 1992

- *Wave Reflection and Its Significance in the Solar Atmosphere* – talk,
  Kiepenheuer Institut für Sonnenphysik,
  Freiburg, Germany – July 1992

- *The Role of Non-Linear Alfvén Wave Coupling in the Heating of Solar Coronal Holes* – talk,
  AGU Spring Meeting,
  Baltimore, MD – May, 1993

- *The Heating of Solar Coronal Holes by Means of Non-Linear Alfvén Wave Coupling* – poster,
  24th SPD Meeting,
  Stanford, CA – July, 1993

- *On Chaos Generated by Nonlinear Alfvén Waves* – paper published in
  Conference Proceedings of Southeastern Simulation Conference, p.98
  Huntsville, AL – October, 1993

- *The Efficiency of Nonlinear Alfvén Wave Coupling in Heating Solar Coronal Holes* – poster,
  AGU Spring Meeting,
  Baltimore, MD – May, 1994